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SOLUTION BY GEO. W. HARTWELL, Hamline University, St. Paul, Minn.

For the given ellipse

$$\frac{dy}{dx} = -\frac{b^2x}{a^2y}, \tag{1}$$

$$\frac{d^2y}{dx^2} = -\frac{b^4}{a^3y}. \tag{2}$$

Also

$$\frac{dy}{dx} = \cot \varphi. \tag{3}$$

Making these substitutions in the usual formula for radius of curvature,

$$R = \frac{(1+\cot^2\varphi)^{3/2}}{\dfrac{b^4}{a^2y^3}} = \frac{a^2y^3}{b^4\sin^3\varphi}. \tag{4}$$

From (1) and (3)

$$b^2x = -a^2y\cot\varphi. \tag{5}$$

Substituting this value of x in the equation of the ellipse, we have

$$a^4y^2\cot^2\varphi + b^2a^2y^2 = a^2b^4.$$

Hence,

$$y^2 = \frac{b^4}{b^2+a^2\cot^2\varphi} = \frac{b^4\sin^2\varphi}{a^2\cos^2\varphi+b^2\sin^2\varphi} = \frac{b^4\sin^2\varphi}{a^2-(a^2-b^2)\sin^2\varphi}. \tag{6}$$

But $a^2 - b^2 = a^2e^2$. Hence

$$y^3 = \frac{b^6\sin^3\varphi}{a^3(1-e^2\sin^2\varphi)^{3/2}}$$

and

$$R = \frac{b^2}{a(1-e^2\sin^2\varphi)^{3/2}}.$$

But $b^2 = a^2(1-e^2)$. Hence,

$$R = \frac{a(1-e^2)}{(1-e^2\sin^2\varphi)^{3/2}}.$$

Also solved by RICHARD MORRIS, C. C. STECK, F. M. MORGAN, J. W. CLAWSON, S. W. REAVES, and J. G. GONZALES.

MECHANICS.

A solution of 273 was received from J. W. CLAWSON too late for the June issue.

271. Proposed by B. F. FINKEL, Springfield, Mo.

A hollow spherical shell is filled with a frictionless fluid and rolls down a rough inclined plane. After rolling t seconds the fluid suddenly solidifies. Determine the subsequent motion of the spherical shell.

SOLUTION BY J. W. CLAWSON, Collegeville, Pa.

Let m be the mass of contained fluid; m' the mass of the shell alone; α the angle of inclination of the plane; a the radius of sphere; x the distance the sphere has rolled from rest after a time T; θ the angle turned through by the sphere after time T; I the moment of inertia of the rotating mass; and T' the time that has elapsed after solidification.

Using the formula for torque, we have

$$(m + m')ga \sin \alpha - (m + m')\ddot{x}a = I\ddot{\theta}.$$

But $x = a\theta$. Hence, $\ddot{x} = a\ddot{\theta}$. Hence, $(m + m')ga^2 \sin \alpha = (m + m')a^2\ddot{x} + I\ddot{x}$, from which we find

$$\ddot{x} = \frac{(m + m')ga^2 \sin \alpha}{(m + m')a^2 + I}.$$

Now, for the first t seconds, $I = 2/3 \cdot m'a^2$, since the fluid does not rotate. (The shell is assumed to be of so small a thickness that its square may be neglected in finding I.) Hence

$$\ddot{x} = \frac{(m + m')gs \text{ in } \alpha}{(m + m') + 2/3 \cdot m'}, \quad \dot{x} = \frac{3(m + m')g \sin \alpha}{3m + 5m'} \cdot t, \quad x = \frac{3(m + m')g \sin \alpha}{3m + 5m'} \cdot \frac{t^2}{2}.$$

After the first t seconds, $I = 2/3 \cdot m'a^2 + 2/5 \cdot ma^2$.

Hence,

$$\ddot{x} = \frac{(m + m')g \sin \alpha}{7/5 \cdot m + 5/3 \cdot m'}, \qquad \dot{x} = \frac{15(m + m')g \sin \alpha}{21\, m + 25m'} T' + \frac{3(m + m')g \sin \alpha}{3m + 5m'} \cdot t,$$

and

$$x = \frac{15(m + m')g \sin \alpha}{21\, m + 25\, m'} \frac{T'^2}{2} + \frac{3(m + m')g \sin \alpha}{3m + 5m'} T' \cdot t + \frac{3(m + m')g \sin \alpha}{3m + 5m'} \cdot \frac{t^2}{2}.$$

285. Proposed by RICHARD P. LOCHNER, Philadelphia, Pa.

A ladder 25 ft. long, weighing 120 lbs., leans against a vertical wall. Its foot is prevented from slipping on the plane by a peg driven into the ground 7 feet from the wall. If a man weighing 150 lbs. is one-third the way up the ladder, what is the reaction on the peg, the ground, and the wall?

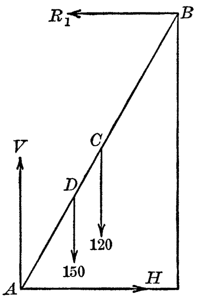
Solution by Richard Morris, Rutgers College.

Denote the reaction against the vertical wall by R_1, that against the peg by H and that against the ground by V, the weight of the ladder being concentrated at its mid-point.

Taking moments about A, we get

$$24\, R_1 = \frac{7}{3} \cdot 150 + \frac{7}{2} \cdot 120 = 770.$$

Hence $R_1 = 770/24 = 32\,{}^1/_{12}$ lbs. $R_1 = H$, since horizontal forces are equal. Also $V = 120 + 150 = 270$, resolving vertically.



Also solved by S. W. Reaves, J. B. Smith, Cifford N. Mills, A. M. Harding, and J. W. Clawson.